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Arrangement of an electrical power generating system in an electrical vehicle, and a method for mounting and/or for installation of the electrical power generating system in the electrical vehicle

The invention relates to an arrangement of an electrical power generating system in an electrical vehicle which contains at least one electrical traction motor, a fuel cell and means for supplying the fuel cell with a combustion gas and an oxidizing gas, and has a load-bearing structure with longitudinal supports, and to a method for mounting and/or for installation of the electrical power generating system in the electrical vehicle.

An electrical vehicle having an electrical power generating system which contains an electrical traction motor, a fuel cell and means for supplying the fuel cell with a combustion gas and an oxidizing gas is already known (DE 4 412 450 A1). The vehicle has a chassis which comprises two longitudinal supports and two transverse supports. A front axle and a rear axle are articulated on the longitudinal supports. The electrical traction motor which is arranged on the front axle is connected to an electrical power controller which is fed from the fuel cell. The fuel cell comprises a stack of individual fuel cells. A reformer, a fuel tank and additional units such as ion interchangers, condensation separators, reformat coolers, heat exchangers, temporary hydrogen stores and fuel cell coolers are provided in order to produce the combustion gas. The oxidizing gas is fed into the fuel cell using a compressor which is preceded by an air filter.

The invention is based on the problem of specifying an electrical power generating and distribution system for an electrical vehicle, which contains prefabricated parts with which the vehicle can quickly be equipped, and a method for simple installation of an electrical power generating system such as this in an electrical vehicle.

According to the invention, the problem in the case of an arrangement of the type described initially is solved in that the electrical power generating system contains a first module with appliances at least for preprocessing and metering of the gases to be fed into the fuel cell and a second module with the fuel cell, which fuel cell is connected to the first module by mechanical coupling means for carrying the gases to be supplied to the fuel cell, for dissipating the reaction gases from the fuel cell, and for carrying at least one coolant via the fuel cell and by electrical coupling elements for the transmission of measured values from sensors, in that the first module and the second module are jointly mounted in a container which can be inserted into a cavity (which is accessible from underneath the vehicle) in the vehicle, and can be attached to the longitudinal supports in the vehicle by means of at least four holders which are fitted to the container longitudinal side walls, and in that an electrical power distribution module, which at least has distribution circuits with fuses and at least one switching element for switching the distribution circuits on and off, can be attached to a side wall of the container and can be connected via coupling elements to the electrical outputs of the fuel cell and to cables to the electrical loads in the electrical vehicle. The electrical power generating system according to the invention accordingly has three modules which can be produced autonomously, two of which are mounted within the container and the third is

connected to an outer wall of the container. The production of the module with the appliances for preprocessing and metering of the gases, and of the module with the fuel cell, can be carried out in a workshop configured particularly for this purpose, in which the connections between the two modules are also made, on the basis of their arrangement, on a jig. This unit comprising the two modules connected to one another is then installed in the container. The assembly formed in this way is suitable as a supply part.

The first module together with the appliances for preprocessing and metering of the gases to be fed into the fuel cell is preferably arranged at the front - seen in the direction of travel of the electrical vehicle - of the container, and is screwed to the bottom of the container. This arrangement allows the module, which is also referred to in the following text as the gas preprocessing module, to be attached quickly and easily.

In a further preferred embodiment, the second module with the fuel cell has a housing which contains the numerous individual fuel cells with electrical connections, and is connected to the container by means of two screws on the rear container bottom and via in each case one holder on the left and right alongside the front face. Particularly when it is designed for relatively high electrical power levels, the fuel cell is relatively heavy and is attached to the container at four points.
In particular, the electrical power distribution model can be attached to an outer wall of the container, which wall is adjacent to the second module and runs transversely with respect to the longitudinal supports. The electrical power distribution module has a lighter weight than the module with the fuel cell, which is

also referred to in the following text as the fuel cell module, and than the gas preprocessing module, and can therefore be handled more easily and can also be attached to the container more easily after the latter has been installed in the electrical vehicle.

It is also expedient to provide at least two holders with guide pins on each of the two longitudinal faces of the container, in which case the guide pins can be pushed into holes in the longitudinal supports in the electrical vehicle, and the holders can be attached to the longitudinal supports by means of screws. This arrangement allows the container with the two modules to be attached to the vehicle quickly and easily.

The holders are preferably designed such that they have movement restriction means, which restrict the movement of the container relative to the longitudinal supports, and allow such movement only in the event of an impact beyond a specific impact strength, and have energy absorption means for controlled transmission of kinetic energy from the container to the longitudinal supports, with energy being at least partially destroyed.

In the case of a method for mounting and/or for installation of an electrical power generating system in an electrical vehicle which contains at least one electrical traction motor, a fuel cell and means for supplying the fuel cell with a combustion gas and an oxidizing gas, and has a load-bearing structure with longitudinal supports, the problem is solved, according to the invention, in that a first module with appliances at least for preprocessing and metering of the gases to be fed into the fuel cell and a second module with the fuel cell are produced, in that the first and the second module are arranged in an apparatus and are then connected to one another by mechanical coupling elements which relate to lines for

the substances to be supplied to the fuel cell and to be dissipated from it, to coolant routing for the fuel cell and to electrical coupling elements for sensor signal transmission between the two modules, in that the modules which are connected to one another by means of the coupling elements are then mounted in a common container, in that the container is then inserted together with the modules into an electrical vehicle from underneath, into a cavity which is provided in this vehicle, and is attached to the longitudinal supports, in that a third module, which contains an electrical connection for the electrical outputs of the fuel cell and electrical power distribution circuits with fuses for the connection of electrical loads and at least one switching element for switching the electrical power distribution circuits on and off, is the attached to the container externally on a side wall, in that the electrical connections are then made from the third module to the fuel cell and to electrical loads in the vehicle, and in that the first module is then connected to a source for the combustion gas and to a channel for the air supply, and is connected by means of inputs and outputs to at least one cooling circuit in the electrical vehicle and to output line for the reaction products from the fuel cell. The method according to the invention makes it possible to produce major components of the electrical power supply system in their own right remote from the vehicle assembly location, and to join them together to form a self-supporting unit which can be transported to the vehicle assembly location and can be installed in this vehicle quickly and easily. Overall, this reduces the amount of effort for assembly of the vehicle. The gas preprocessing module is mounted in the front - seen in the direction of travel - of the container, in particular by means of two screws. The fuel cell module is expediently mounted by means of two screws in the rear part of the container bottom, and by means of two

holders, which are each arranged on one face of the module, on the longitudinal side walls of the container. A mechanical interface between the gas preprocessing module and the fuel cell module in each case includes inputs for hydrogen gas and air, inputs and outputs for at least one cooling medium, and outputs for the reaction products. An electrical interface is provided for the measured values from pressure and temperature sensors. The coupling elements of the interfaces are produced in a jig after the arrangement and connection of the gas preprocessing module and of the fuel cell module. The modules which have been connected to one another are then mounted in the container. The container together with the two modules is then installed in the electrical vehicle by being pushed on a lifting device into a cavity in the vehicle, and by then being screwed to the longitudinal supports at four holders, which are fitted to the longitudinal faces of the container. An electrical power distribution module, which contains connections for the electrical outputs of the fuel cell and outgoer lines with fuses for the connection of electrical loads in the vehicle, and an on/off switch for the outgoer lines, is then attached to a wall of the container which runs transversely with respect to the longitudinal supports. The electrical connections are then made. Finally, connections are also made from a hydrogen source to an input on the gas preprocessing module, from an air induction channel to the gas preprocessing module, and from there to output lines for the reaction products of the fuel cell, to vent lines and to a coolant source.

The invention will be described in more detail in the following text with reference to one exemplary embodiment, which is illustrated in a drawing, and from which further details, features and advantages will become evident.

In the figures,

Figure 1 shows a side view of an electrical power generating system, which is composed of modules and is arranged in a container, for an electrical vehicle,

Figure 2 shows a perspective view from above of an electrical power generating system, which is composed of modules and is arranged in a container, for an electrical vehicle,

Figure 3 shows a section through longitudinal supports in an electrical vehicle having a container, which is attached to the longitudinal supports, with modules of an electrical power generating system, shown schematically in a view from the front.

An electrical power generating system 1 for an electrical vehicle has a first module 2 with appliances for preprocessing and metering of the gases to be fed into a fuel cell. The gases are, for example, hydrogen as the combustion gas and air as the oxidizing gas. The module 2 has an input 3 for hydrogen which is supplied via a metering valve to the fuel cell, with the fuel cell being arranged in a second module 4. Components which are not illustrated, such as a compressor for the air, an air filter, sensors for the pressure, temperature and gas flow rates, and further components for the metering of hydrogen are provided in the module 2. The module 4 contains the fuel cell (which is in the form of a stack of individual fuel cell elements) with connections for the supply of hydrogen, air, coolant, and outputs for the reaction products as well as electrical connections for the emission of currents and measured values from sensors in the fuel cell.

For the transmission of the coolant, for example water, hydrogen gas, air and the reaction products of the fuel cell, interfaces for coupling elements are provided between the two modules 2, 4, two of which coupling elements 5, 6 are illustrated in Figure 2. Further electrical interfaces, which are not illustrated, are likewise provided for the transmission of measured values from sensors that are arranged in the fuel cell, with the corresponding coupling elements. In addition to the input 3, the module 2 has inputs and outputs for the coolant, an input for air and at least one output for the reaction products of the fuel cell. Two such inputs and outputs 7, 8 are illustrated in Figure 2.

The two modules 2, 4 are jointly arranged in a container 9, which is in the form of a trough and whose bottom forms a part of the lower face of the respective electrical vehicle. The module 2 together with the appliances for the preprocessing and metering of the gases is mounted by means of screws (11) on the bottom 10 of the container 9 at the front - as seen in the longitudinal direction of the vehicle. The module 4 with the fuel cell has a housing which contains numerous individual fuel cell elements, although these are not illustrated. The module is screwed to the bottom 10 of the rear part of the container 9 by means of two screws (12). Furthermore, the module 4 is attached by means of screws 14 to the side walls of the container 9 via two holders 13 which are located at the side on the left and right of the front surface of the container 9.

A third module 15, which is also referred to as electrical power distribution module, contains connections for the electrical outputs of the fuel cell and outgoers with fuses for the electrical loads on the high-voltage network, which is fed from the fuel cell,

of, for example, 200 V-400 V in the electrical vehicle, and at least one on/off switch for the outgoers. Seen in the forward direction of travel of the vehicle, the module 15 is attached on the outside to the rear wall 16 of the container 9. This wall 16 is adjacent to the module 4. Two or more plug connector elements, of which the plug connector elements 18, 19 and 20 are identified, are located on a wall 17 of the module 15. The plug connector elements, for example 18, 19, 20, are intended for the connections for cables which lead to the loads on the high-voltage network.

Two holders 21, 22 are in each case attached to the two longitudinal faces of the container 9, that is to say the faces which run transversely with respect to the longitudinal supports in the vehicle, and are intended for the attachment of the electrical power generating system 1 to the vehicle. The holders 21, 22 are attached by means of screws 23 to two longitudinal supports 24, 25 of a load-bearing structure of the electrical vehicle. The holders 21, 22 have guide pins which project into corresponding holes (which are not illustrated in any more detail) in the longitudinal supports 24, 25 and are provided for rapid alignment of the container 9 with respect to the location of that attachment to the longitudinal supports during assembly. The holders 21, 22 are equipped with movement restriction means, which restrict the movement of the container 9 relative to the longitudinal supports 24, 25 and allow such movement only in the event of an impact of the vehicle beyond a specific impact strength. Furthermore, the holders 21, 22 have energy absorption means for controlled transmission of kinetic energy from the container 9 to the longitudinal supports 24, 25, with at least partial energy dissipation. The holders 21, 22 have a type of framework, which allows oscillating movements of the type described above. DE 197 38 620 C1 describes a

holder for a battery mount in an electrical vehicle, which allows the movements described above and the energy dissipation in the event of a crash.

The modules 2 and 4 are each produced separately, with the components, which are not illustrated in any more detail, being inserted into the modules and being mounted in them. The connections which are required between the components are then made in the modules 2 and 4. The two modules 2, 4 are then fixed and connected to one another in an apparatus, for example a jig. Once the coupling elements have been fitted between the two modules 2, 4, the modules are inserted into the container 9. The module 2 is screwed to the bottom 10 of the container 9, at the front. At the rear, the module 4 is screwed to the bottom 20 of the container, and to the side walls of the container 9. The container together with the modules 2, 4 represents a robust unit which can be transported on its own and which can be manufactured in particular as a supply part for an electrical vehicle. A heavier fuel cell is required in order to achieve more power. The container together with the modules 2, 4 is placed on a lifting device and is raised from underneath into a cavity (which is provided for this purpose) in the jacked-up electrical vehicle, until the guide pins 26 engage in the holes which are provided for this purpose in the longitudinal supports 24, 25, and the holders 21, 22 rest on the longitudinal supports 24, 25. The holders 21, 22 are then screwed to the longitudinal supports 24, 25. The module 15 is then pushed from underneath in guide rails on the wall 16 as far as a stop, which is not illustrated in any more detail, and is attached to the wall 16 by means of screws. The contacts (which are not illustrated) on the fuel cell and on the module 15 are then connected to one another. Once the module 15 has been fitted to the wall 16 of the container 9 that is mounted in the electrical vehicle, and once the

electrical connections between the fuel cell and the module 25 have been made, the connecting line 28 for the hydrogen supply to the `1input 3, the lines to the inputs and outputs for air, the reaction products and cooling water are laid. A high-temperature and a low-temperature cooling circuit can be arranged in the vehicle, both of which are passed to the modules 2, 4 via the container. The means for provision of the hydrogen, for example a hydrogen tank, will have already been fitted in the electrical vehicle before the installation of the electrical power supply system 1.